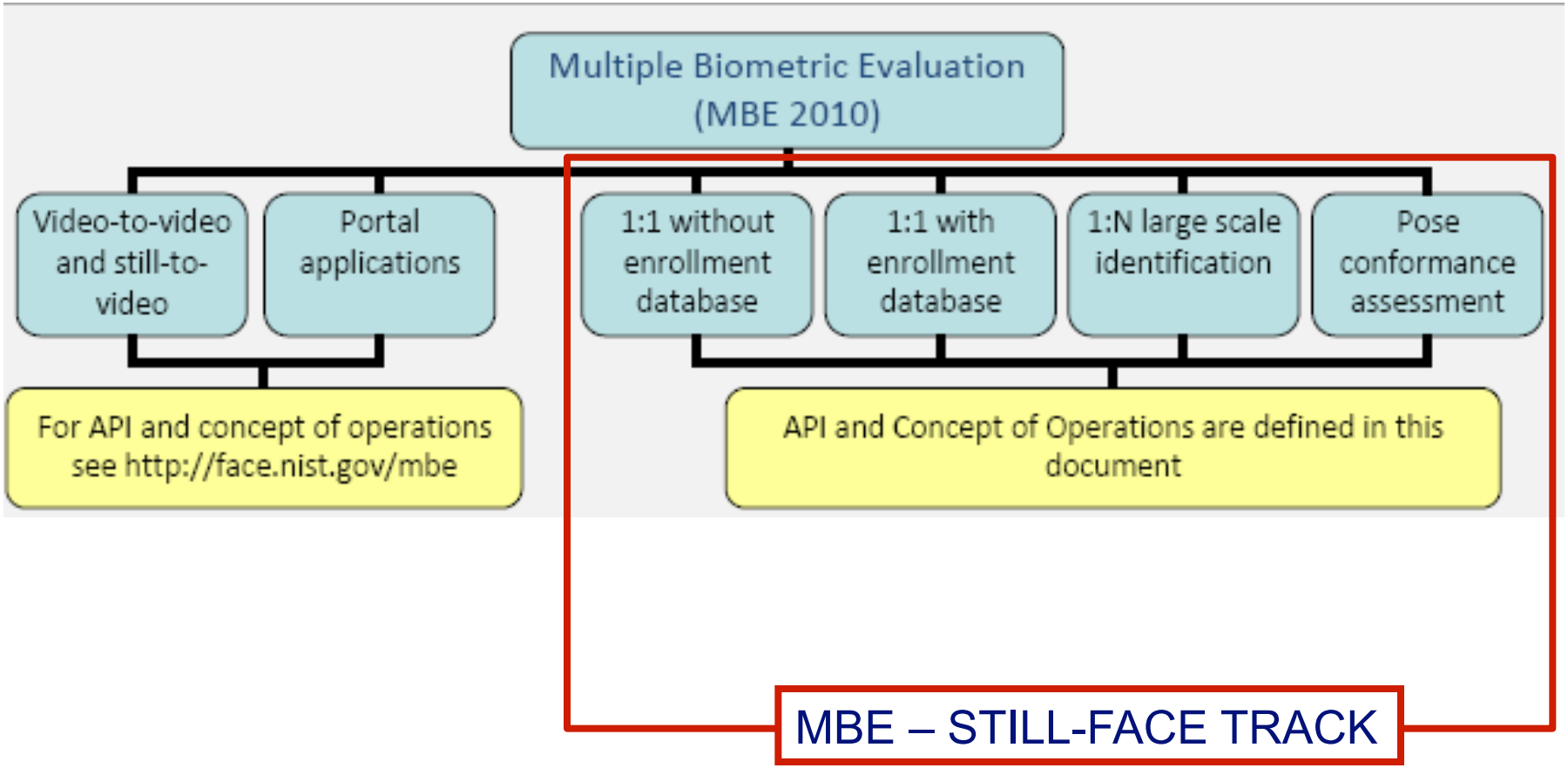
IREX + MBE + MINEX I + MINEX II + PIV NIST update Session

patrick.grother@nist.gov

Chapter I :: MBE-STILL

Large-Scale Face Recognition Testing

MBE Organization



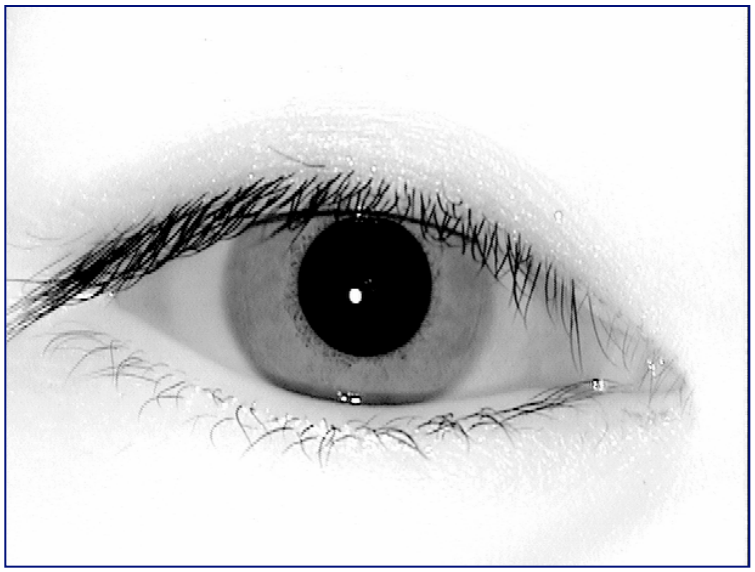
MBE-STILL :: What's new about this test?

- Largest public 1:N test ever conducted
  - **N → 3 million**
- Enroll lifetime history
  - **Of visa images (DOS/DHS)**
  - **Of arrest images (FBI)**
  - **Vendor executes fusion**
- Provide operational metadata to the algorithm
  - **Sex | Height | Weight | Date of birth | Date of Picture**
- Report resource usage:
  - **Time, storage, memory…**
- Pose conformance testing
  - **Quantify deviation from standard.**
- Explicitly split 1:1 testing
  - **With enrolled DB (time+attend)**
  - **Without enrolled DB (e-Passport)**
- Test iteratively
  - **Provide feedback to developers**
  - **Drive R&D, improved performance**
- Support application of statistical methods on the enrolled database
  - **"Training"**
  - **Feature space separation, normalization**

Chapter I :: IREX

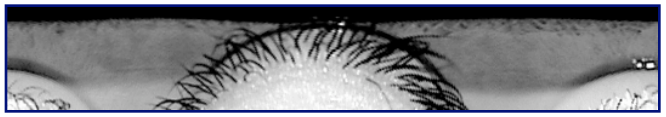
The Iris Exchange (IREX) Program
Supporting IRIS Interoperability

IREX I :: Tested Image Formats



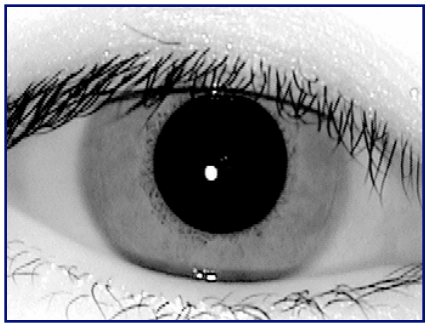
Parent image from camera

KIND 1



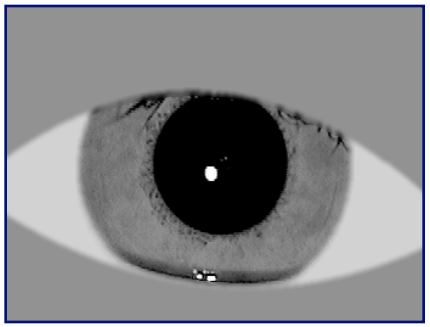
Unsegmented polar

KIND 16



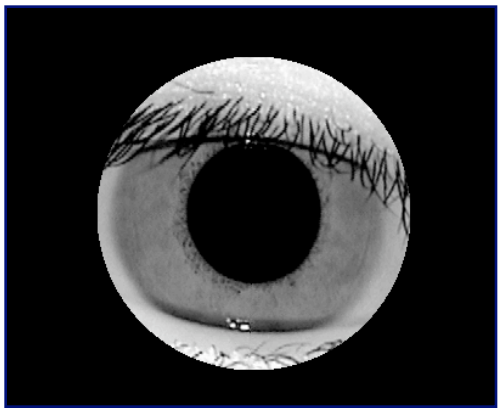
Cropped image

KIND 3



Cropped and masked image

KIND 7



Reconstructed rectilinear

KIND 48

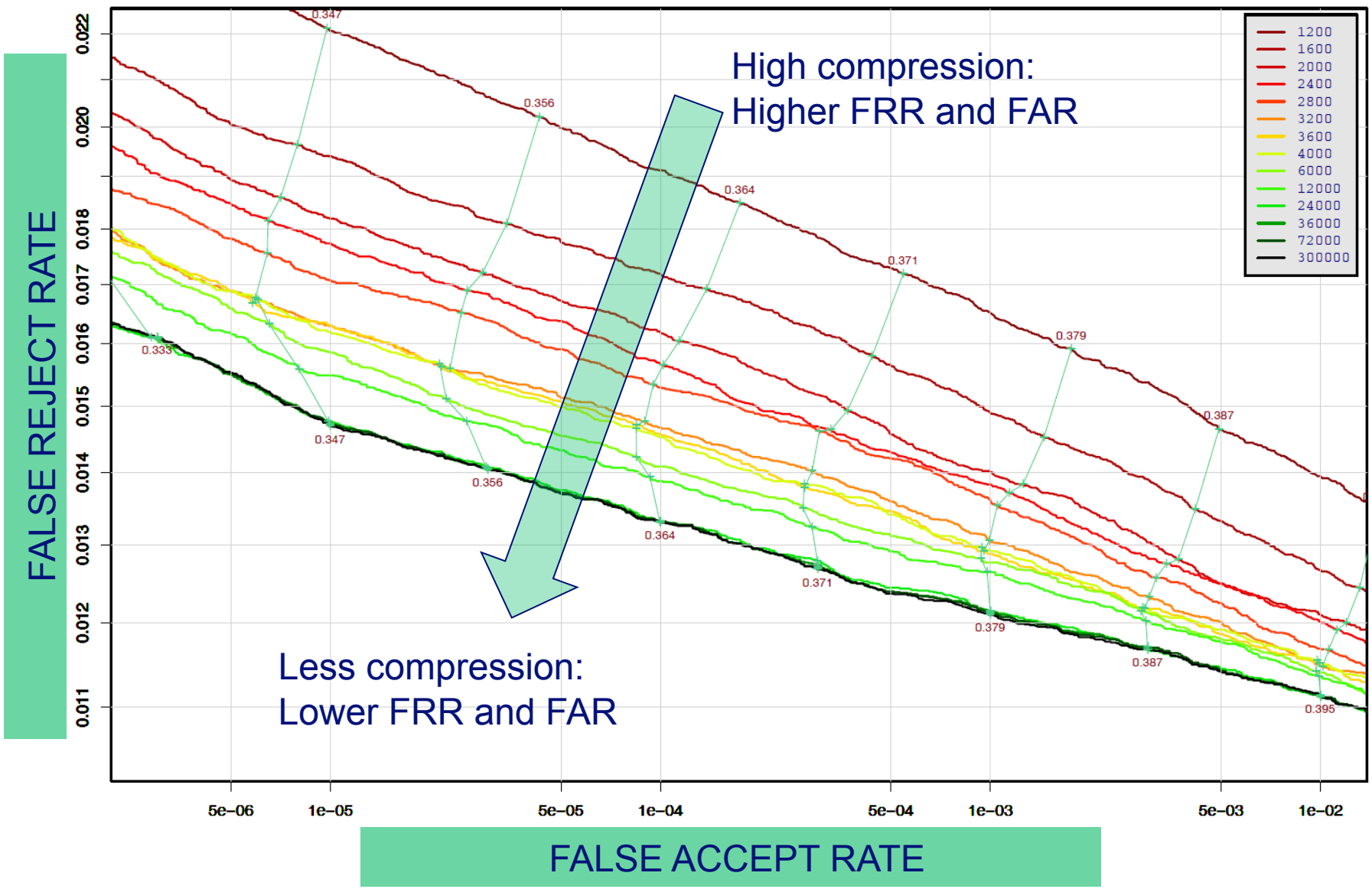
Compression + Format Recommendations

- Compression – Avoid it when you can!
  - **Lossy compression does incremental damage to images.**
  - **Either no compression, or lossless may be sufficient.**

	Recommended		Target Record Size								
Role	Format	Compressor	2KB	4KB	8KB	16KB	32KB	64KB	128KB	256KB	307KB
All	KIND 1	Uncompressed									
All	KIND 3	Uncompressed									
All	KIND 7	Uncompressed									
All	KIND 3	PNG Lossless									
All	KIND 7	PNG Lossless									
1:N	KIND 3	JPEG 2000 Lossy									
1:N	KIND 7	JPEG 2000 Lossy									
1:1	KIND 3	JPEG 2000 Lossy									
1:1	KIND 7	JPEG 2000 Lossy									

Lossless for 1:N
Apps over networks

Recognition Error Under Compression



In 144 pages IREX covers

- Effect of lossy compression
  - **JPEG vs. JPEG 2000**
- Limits of lossless compression
- Effect of iris radius
- How closely to crop the iris?
- Comparison of specialized formats
  - **Masked vs. Polar**
  - **Fit for purpose**
- Effect of pupil dilation
  - **Change in dilation**
- Effect of eyelid occlusion
- Effect of iris-pupil displacement

- Accuracy
  - **ROCs**
  - **Fixed threshold – effect on FMR and FNMR**
- Speed accuracy tradeoffs
- Template size
- False Match Rate Calibration
  - **How to set the threshold**
- Effect of dataset
- Algorithm interoperability
  - **Enroll on A – Identify on B**
- Image quality assessments
- Biometric zoo

IREX – Umbrella Program Supporting Iris Interoperability

L1 Pier 2.4

CrossMatch Seek

Can an image acquired on the L1 PIER be matched against an image gathered on another sensor, for example the CrossMatch SEEK?

Image based Interoperability

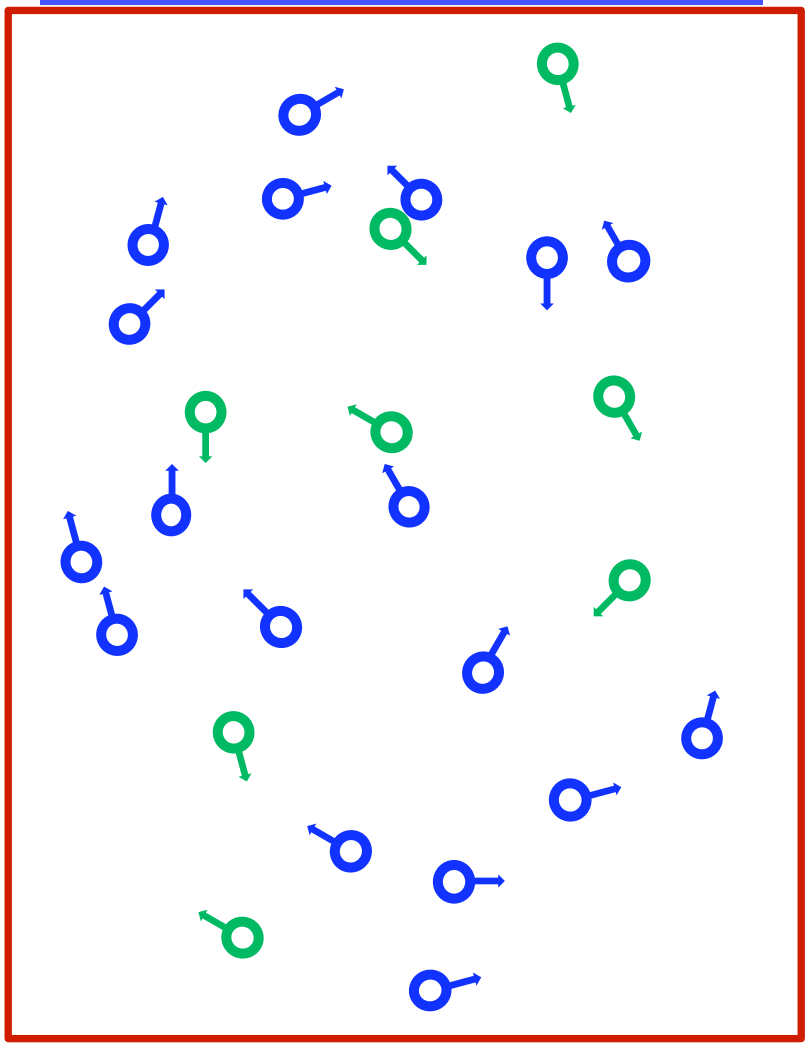
Chapter II :: MINEX I

Core Interoperability of Minutia Templates

Minutia Matching

Minutiae from enrollment image

Minutiae from verification image



Interoperability of Minutia Templates

False Non-Match Rate at False Match Rate of 0.01		Supplier of Verification Template + Template Matcher		
		NEC		
Supplier of Enrollment Template	NEC	0.0129		

Red values refer to NATIVE performance : One vendor generates both templates and matches them.

Interoperability of Minutia Templates

False Non-Match Rate at False Match Rate of 0.01		Supplier of Verification Template + Template Matcher		
		NEC	Sagem	
Supplier of Enrollment Template	NEC	0.0129	0.0205	
	Sagem	0.0316	0.0140	

Red values refer to NATIVE performance : One vendor generates both templates and matches them.

Interoperability of Minutia Templates

False Non-Match Rate at False Match Rate of 0.01		Supplier of Verification Template + Template Matcher		
		NEC	Sagem	Cogent
Supplier of Enrollment Template	NEC	0.0129	0.0205	0.0300
	Sagem	0.0316	0.0140	0.0207
	Cogent	0.0417	0.0225	0.0136

Red values refer to NATIVE performance : One vendor generates both templates and matches them.

MINEX

- FIPS 201 regulates PIV
  - **Binding on agencies under FISMA**
- Supported by special publications
  - **SP 800-76-1 Biometrics**
  - **SP 800-73 PIV Card Interfaces**
- MINEX is used for certification against fixed performance interoperability specification
  - **Of 58 algorithms submitted**
    - **32 compliant INCITS 378 template generators**
    - **26 compliant INCITS 378 template matchers**

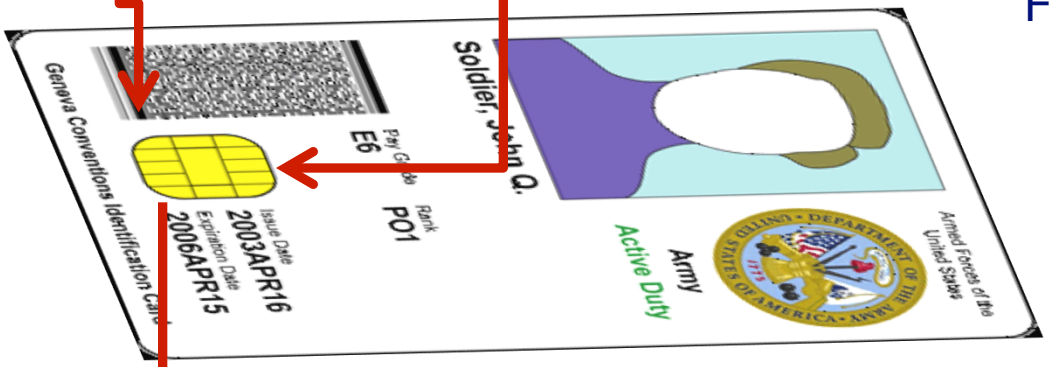
Chapter III :: MINEX II

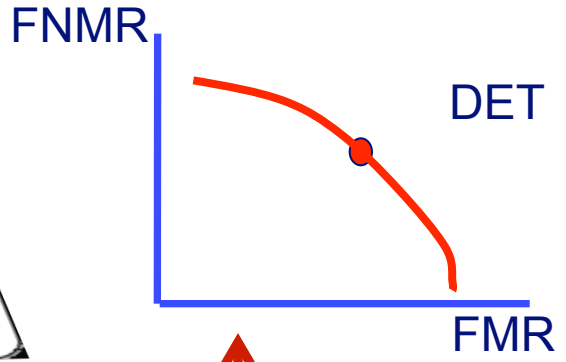
On-card comparison of ISO/IEC 19794-2 minutia records on ISO/IEC 7816 smart cards

MINEX II – Algorithms on Cards

Reference Template:
sent via PUT DATA

Verification Template
sent via VERIFY





Similarity Score
via GET DATA

MINEX II Objectives

- Given ISO/IEC 7816 cards are unpowered crypto-tokens with limited computational resources
  - **Can on-card accuracy approach off-card?**
  - **What's the duration?**
  - **Test standardized as ISO/IEC 19795-7 at final (FDIS) ballot.**
- As a by-product
  - **Define procedure for conversion INCITS 378 as a parent for ISO/IEC 19794-2:2005 compact format:**
    - **Drop minutia → Sort minutia → Drop Resolution → Quantize theta**
  - **Quantify accuracy loss**
  - **Open source code**

MINEX II :: Now in fourth phase

PHASE I	PHASE II	Phase III	Phase IV
▫ Jul 07 - Oct, 07 ▫ 11 algorithms ▫ Precise-TecSec ▫ Neurotechno-IRM ▫ Sagem Orga ▫ Oberthur-id3	▫ Nov 07 - Feb 08 ▫ 9 algorithms ▫ G+D ▫ Sagem Orga ▫ Oberthur -id3	▫ Nov 08 - May 09 ▫ 7 algorithms ▫ Gemalto-Micro-Packs ▫ Gemalto-Cogent ▫ Gemalto-Innovatrix ▫ Oberthur-id3	▫ Feb 19, 2010 ▫ 17 algorithms ▫ 8 card suppliers ▫ 8 algorithm suppliers
▫ Non-public	▫ Public Report NIST Interagency Report 7477	▫ Public Report May 2009 as NISTIR 7477 (Rev)	▫ Public Report due June 2010

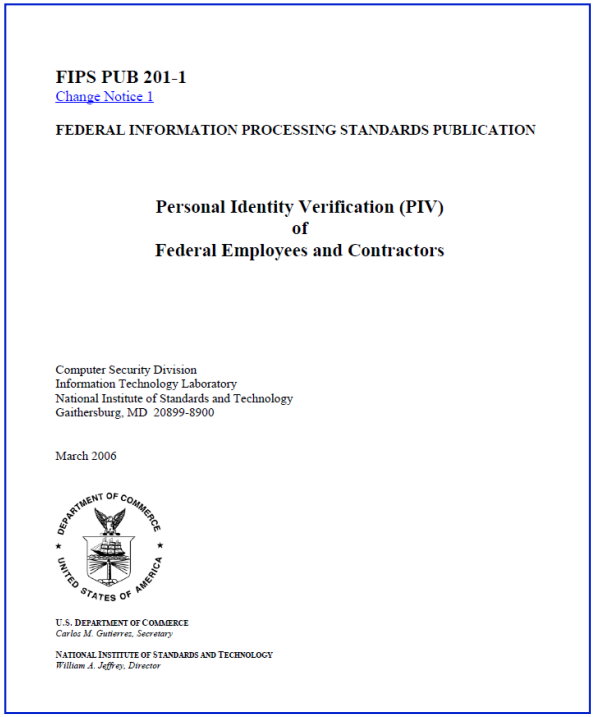
Participant = Team of { Card vendor + Fingerprint matcher vendor }

Chapter II :: PIV

An update on the Biometric Components of the Personal Identity Verification Specification

PIV :: Documentary History

- FIPS 201
  - **Legally binding on USG agencies**
  - **Points to NIST Special Pubs**
- NIST Special Pub 800-76
  - **Version - 0: January 2006**
  - **Version - 1: February 2007**
  - **Version - 2: Spring 2010**



FIPS PUB 201-1
Change Notice 1

FEDERAL INFORMATION PROCESSING STANDARDS PUBLICATION

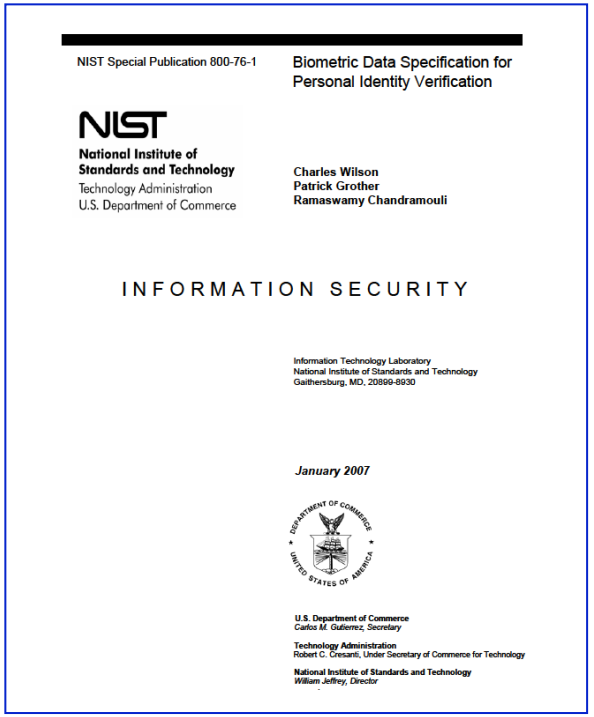
Personal Identity Verification (PIV)
of
Federal Employees and Contractors

Computer Security Division
Information Technology Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8900

March 2006

U.S. DEPARTMENT OF COMMERCE
Carlos M. Gutierrez, Secretary

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
William A. Jeffrey, Director



NIST Special Publication 800-76-1

Biometric Data Specification for Personal Identity Verification

NIST
National Institute of Standards and Technology
Technology Administration
U.S. Department of Commerce

Charles Wilson
Patrick Grother
Ramaswamy Chandramouli

INFORMATION SECURITY

Information Technology Laboratory
National Institute of Standards and Technology
Gaithersburg, MD, 20899-8930

January 2007

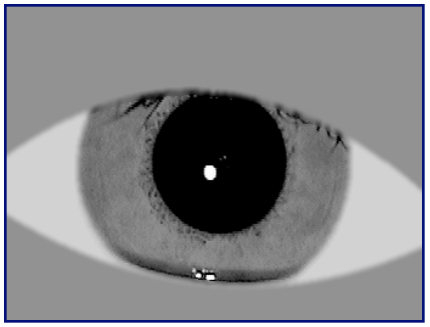
U.S. Department of Commerce
Carlos M. Gutierrez, Secretary

Technology Administration
Robert C. Cresanti, Under Secretary of Commerce for Technology

National Institute of Standards and Technology
William Jeffrey, Director

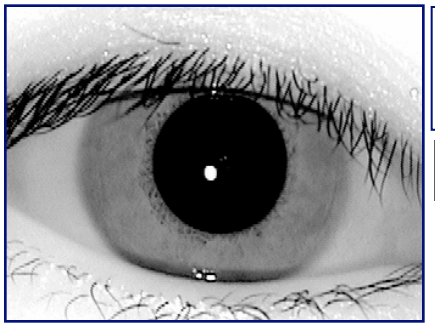
Iris specifications for PIV

- SP 800-76-2 specifications (under consideration):
  - Iris image (for card)
  - Iris image (for CMS)
  - Camera specifications
    - Performance
    - Capture API
  - Conformance testing
- Comment is welcome
  - Now, and
  - on draft of SP 800-76-2



Cropped masked image

KIND 7



Cropped image

KIND 3

IREX Test (Support for 1:1 and 1:N)

- NIST Interagency Report 7629, Sep 21, 2009
  - ***Performance of Iris Recognition Algorithms on Standard Images***
- Quantitative support for ISO 19794-6 standard
  - **Image size is about 3KB (for 1:1) and ~30KB (for 1:N)**
  - **Compression, cropping, formatting profiles**
  - **Speed-accuracy tradespace**
- Ten implementations of standardized interoperable iris image format
  - **Num. iris providers has expand x10 in last five years**
  - **Num core technology providers in iris exceeds that for face recognition**
- Iris image interoperability superior minutia interoperability
  - **Less dependency on the product that prepares the record**
- http://iris.nist.gov/irex (or google “iris interoperability”)

Match-on-Card in PIV :: Near Term

- Possible near-term way forward:
  - **Use a separate MOC application for card activation**
  - **Use a trimmed down version of the MINEX II MOC interface for the APDUs**
    - **It has been implemented by nine organizations, and used successfully**
    - **It's openly documented in NIST Interagency Report 7485**
  - **Use of two fingers would satisfy FIPS 140-2 requirements on false match**
  - **Contact interface**
  - **GICS compliant**

Match-on-Card in PIV :: Longer Term

- Longer term way forward
  - **Formally include MOC in a future FIPS 201-2**
    - **For card activation, and**
    - **As an authentication mechanism**
  - **Leverage NIST IR 7485 for interface**
  - **Leverage NIST IR 7452 for confidentiality**
    - **Or implementations of 7816 secure messaging**
  - **Meet FIPS 140-3 (not FIPS 140-2)**
  - **Consider ISO/IEC 24787**

Thank You

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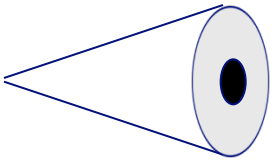
301 975 4157

The role of Interoperable Images

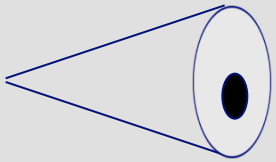
The old paradigm



Proprietary template (iris code) typically ≤ 1KB.

Single supplier iris recognition algorithm

The new paradigm



IG 100

AOPTIX

Standardized Iris Image Record ISO/IEC 19794-6

2KB to 308KB

Supplier A of iris recognition algorithms

Supplier B

Supplier C

DoD :: Operational Context

- Question to Tom Dee during Keynote Q+A, DOD Biometrics + Forensics Summit, San Diego, May 12, 2009:
  - **"Has any progress been made on getting the biometric data from OCONUS to CONUS?" … "This is like moving a bowling ball down a garden hose". [Special Ops, Ft. Bragg]**
- Question to breakout S&T Panel, May 12, 2009 PM:
  - **"Is anyone working on compression, reducing the data for COMMs". [Marine Corps Sys. Command]**

Why compress?

- Small pipes, data is “big”, many transactions
  - **Net-centric**
    - **DHS :: Ports of Entry → IDENT**
    - **DoD :: Battlefield → ABIS**
  - **Card-centric**
    - **Credentials (USG, PIV, FRAC, CAC) :: Smart cards,**
- Example:
  - **AEGIS Destroyer to CONUS. With a channel at 128 kbps, biometric = single 640x480 uncompressed iris ~ 308KB → 19.25 seconds**

IREX I :: Highlights

- 10 Recognition Algorithm Companies
  - **9 Commercial, 1 Academic**
  - **Standards conformant products ready-to-go**
- Three iris datasets
  - **Approx 10000 persons, and 100000 images.**
- Largest public independent evaluation to date
- Not a test of cameras or systems
  - **Not a prediction of operational accuracy**
- Support interoperable images
  - **Replace template-based exchange**
  - **Evaluate formats**
  - **Establish limits of compression**
- Quantitative support for the standards
  - **ISO standard images**
    - **Binary record AND**
    - **Semantic properties of images**
  - **ANSI/NIST**

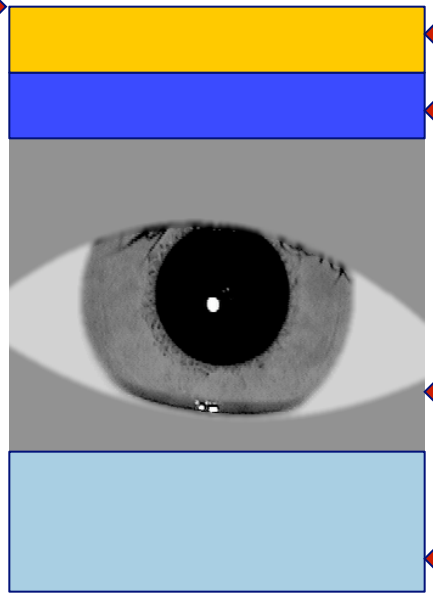
Relevance to HSPDs

- Existence of standardized interoperable iris image records supports
  - **Counter terrorism objectives of HSPD 6, 11, 24**
  - **Cross agency / government exchange**
- Quantified compression response addresses
  - **Real operational bandwidth constraints (e.g. HSPD-24)**
  - **Use of compressed iris data in blue-force applications (e.g. as a standardized data element on PIV/CAC cards for HSPD-12)**

Iris data to go on PIV Cards

Following the arrangement of fingerprint minutia data on current PIV cards… Two iris in one container.

Tagged biometric container (SP 800-73)



CBEFF Header — =88 bytes

ISO Iris Image Header — ≥107 bytes

ISO Iris Image Data — ~2 * 3KB

CBEFF Signature block — ~ 500 bytes

2.65M cards issued 07/2009

Chapter III :: MBE-STILL

1:N Face testing tailored to the FBI Next Generation Identification Program

Exploit all prior encounters

Enroll all prior encounters under a single ID

Transmit to NGI

or ABIS etc

Identification of a new Image

The MBE-STILL API supports the idea of a MULTIFACE, each tagged with metadata.

Vendor implementation determines fusion strategy.

MBE-2D STILL :: Test Design Objectives I

- Maintain virtues of technology / offline testing
  - **Level playing field for comparative testing**
  - **Repeatability, traceability**
- Add maturity to the testing capability
  - **Publish a re-usable API; Solicit public / supplier comments on API**
  - **Measure duration of all function calls**
  - **Measure template size**
  - **Test iteratively :: Provide results + feedback to vendors**
- Making a technology test have operational realism
  - **Use operational data!**
  - **Extend population size to N > 10^6**
  - **Execute a proper identification test**
    - **Don't model 1:N as being N 1:1s**
    - **Open-universe (use impostors, use true impostors) search**
  - **Make sample data available in advance**

MBE-2D STILL :: Test Design Objectives II

- To support face recognition accuracy via data
  - **Exploit multiple historical images of an individual**
    - **Allow the implementation to execute fusion**
  - **Exploit operational metadata :: Provide to implementation**
    - **Date of capture | Date of birth | Height | Weight | Sex**
  - **Allow implementation to execute post-enrollment processing on the enrolled database**
    - **Feature space normalization, for example.**
- To support face recognition accuracy via structuring the API to allow algorithms, Support Performance

1:N in FBI (and USG)

CHARACTERISTICS OF THE FBI TASK

- One-to-many, with N → 10^8
- Aided by multiple arrest records
  - i.e. multiple enrolled images
- A federated application
  - State + local + others → FBI
  - Heterogeneous images
- Aided by face standards … but
  - Pictures don't conform to standards
  - Pictures vary despite mug-shot standards
- Aided by metadata
  - Age, location, gender …
- Here now, and on the NGI radar

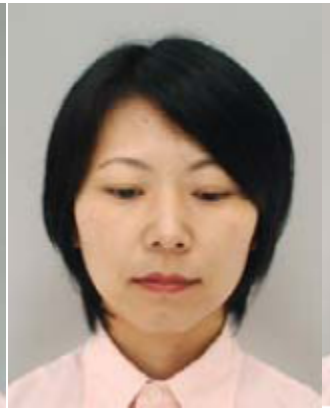
TAILORED TESTING TOWARD IT

- Run a test in proper 1:N mode
  - Est: 10^6 people, 10^7 images
  - Operational images
- Run a test with K ≥ 1 enrollment images per subject
  - Use even the profile views
  - Implementation exploits samples
- Inform the SDK as to the properties of the images
  - Subject specific: Ethnicity, sex
  - Image specific: Age, date
- Run fast
  - Public review of open API
  - "Thin", automatic, test reports
  - FIFO participation

Standards – And deviations from…

ISO Standard

Expression



Gaze

Too close

Pose Angle

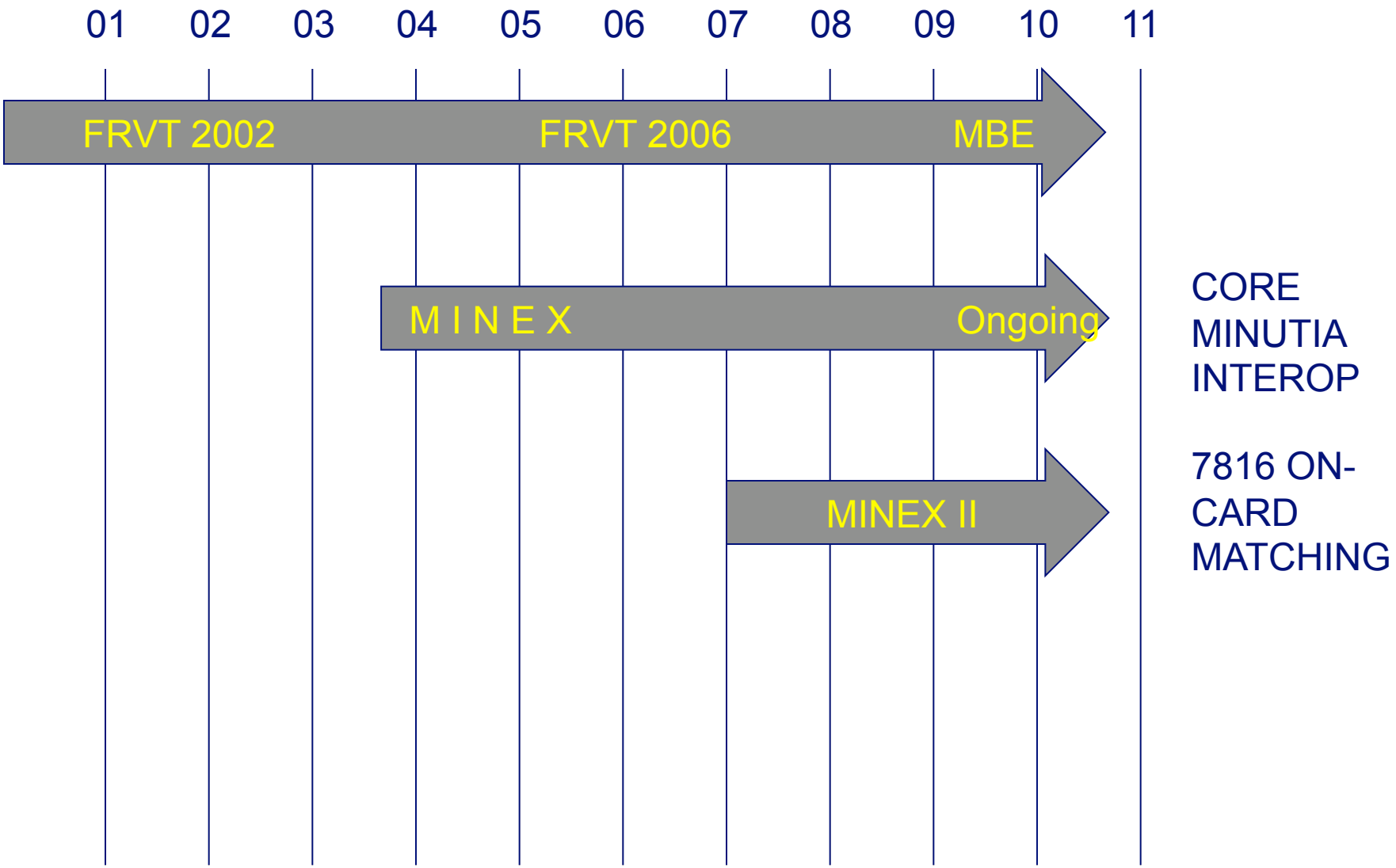
NEC Corporation
Cross Match Technologies

MINEX I

- Initial test of INCITS 378 performance (vs. image) and interoperability between products

BIO-key International, Inc.
SPEX Forensics
SecuGen Corporation
Startek Engineering Incorporated
123ID, Inc.
Sonda Technologies Ltd.
Aware, Inc.
SONATEQ
Griaule Tecnologia Ltda
Precise Biometrics

Startek Engineering Incorporated
NITGen Co., Ltd.


01
02
03
04
05
06
07
08
09
10
11
FRVT 2002
FRVT 2006
MBE
M I N E X
Ongoing
MINEX II
CORE
MINUTIA
INTEROP
7816 ON-
CARD
MATCHING

Agenda

- Iris Recognition (The IREX Program)
  - **Standardized, tested, multi-vendor implemented standard iris images → expanding marketplace.**
  - **Iris Exchange (IREX) :: Relevance to HSPDs 24, 12, 11, 6.**
- IBPC Conference (NIST March 1-5, 2010)
  - **Performance: How to define, how to get it, how to test it, how to procure it, how it's not the whole story.**
- Face Recognition (MBE-STILL)
  - **Testing tailored to the open-set 1:N identification problem (e.g. criminal / KST identification, fraud detection, watchlists).**